

Bats and Wind Energy: Predicting Risk and Designing Mitigations



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Impacts of Wind Energy on Wildlife



Impacts of Wind Energy on Raptors

Altamont Pass

Annual Fatality Estimates

54 – 109 Golden Eagles

213 – 749 Red-tailed Hawks

70 – 1013 Burrowing Owls

519 – 2227 Total Raptors



Photo: Alameda County

Alameda County



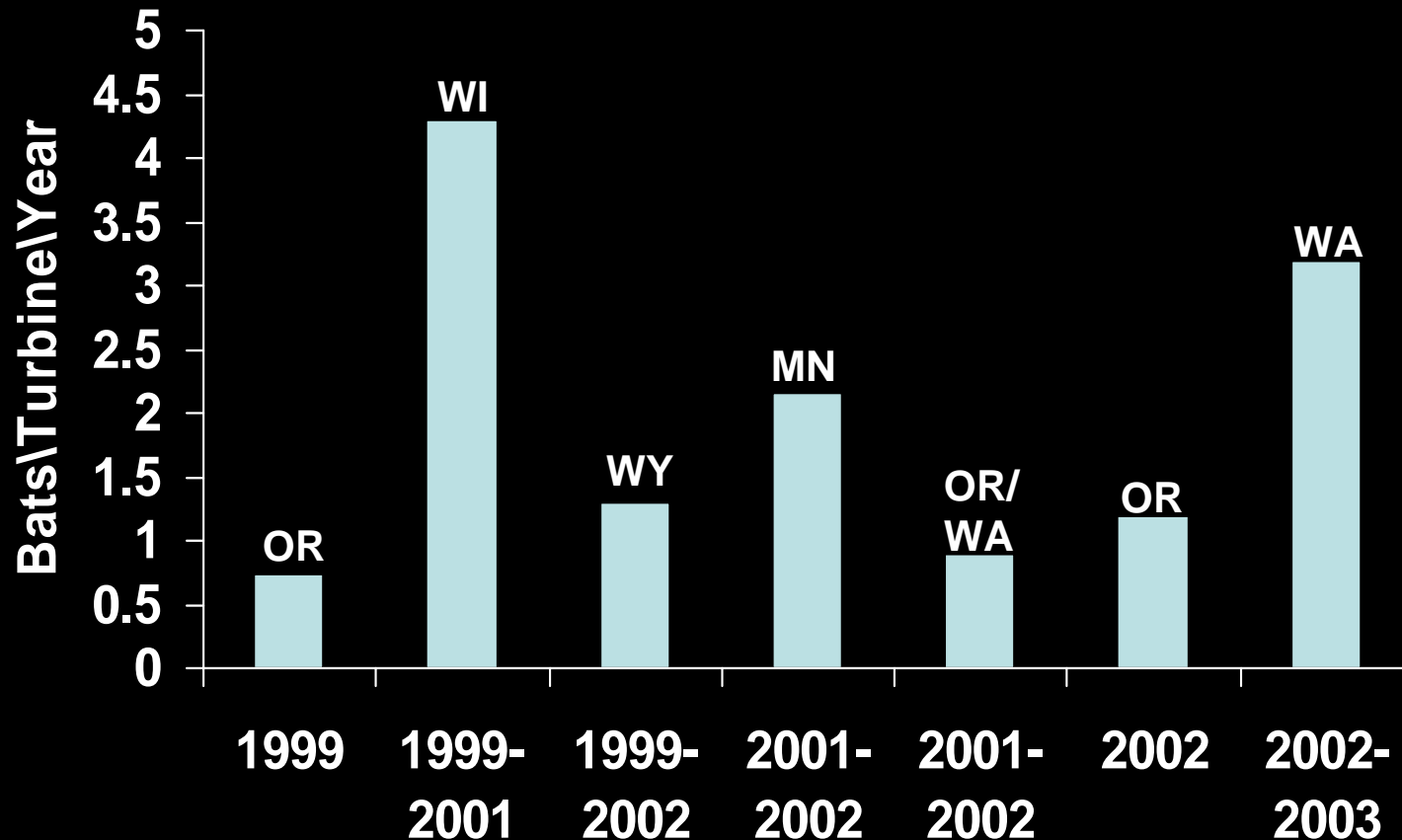
Photo: Alameda County

Alameda County / Courtesy to the Chronicle

Smallwood and Thelander 2008;
J Wild Manage 72:215-223.

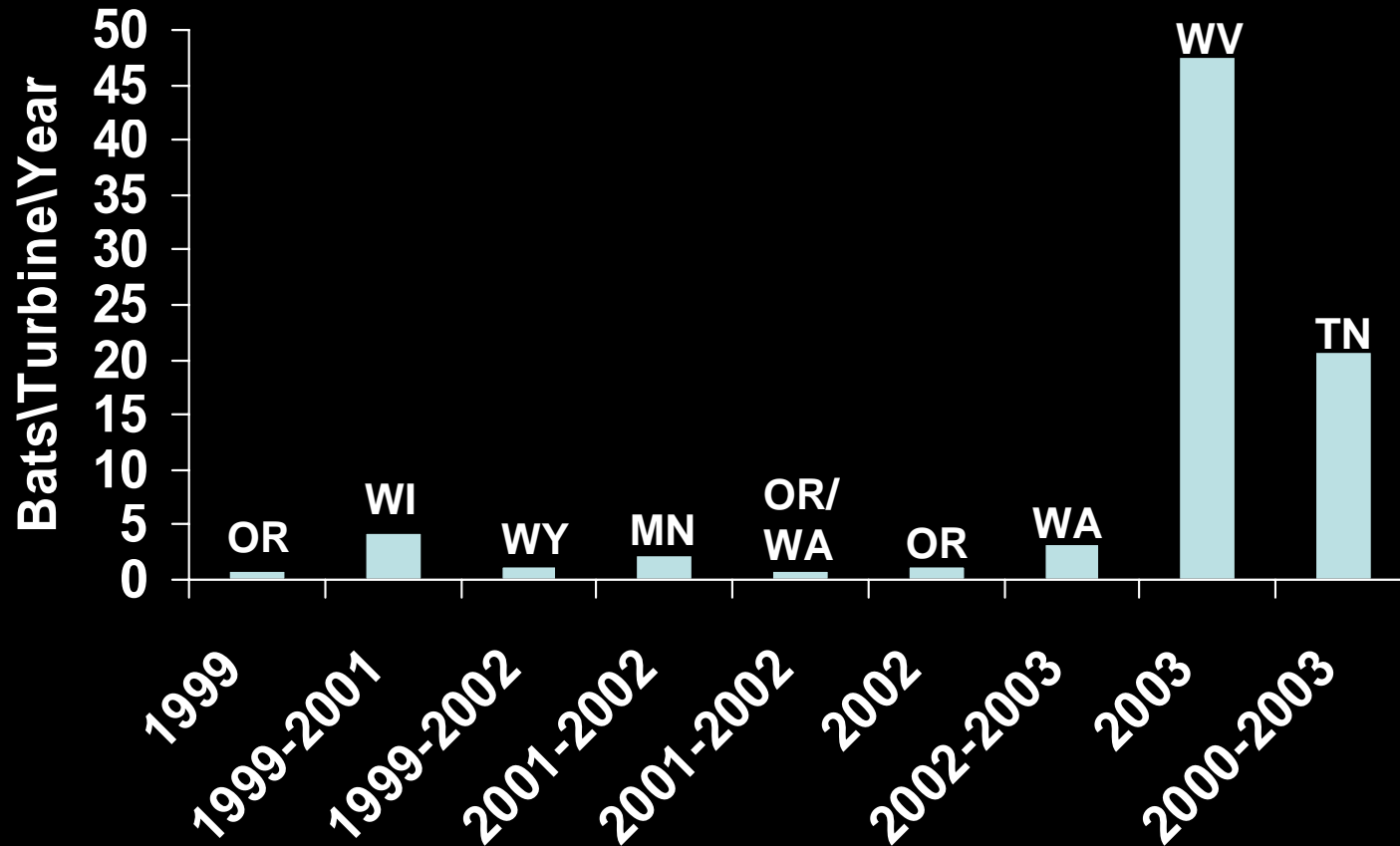
Bat Fatalities at Wind Facilities

Unadjusted Fatality Rates



Bat Fatalities at Wind Facilities

Unadjusted Fatality Rates



Problem Areas for Siting?



Adjusted Fatality Rates

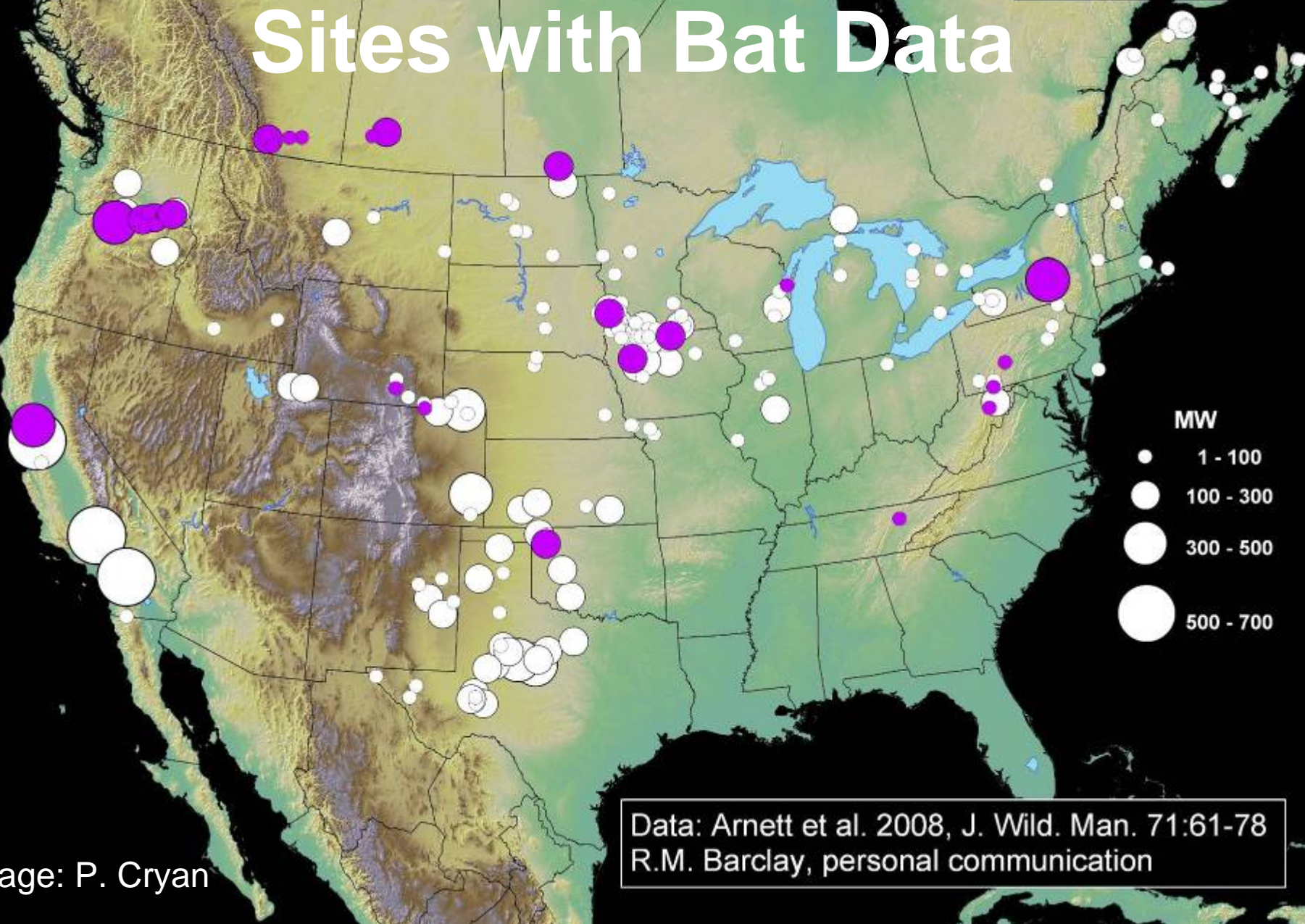
Meyersdale, PA 38 bats/turbine => 1364 – 1990 bats

Mountaineer, WV 25 bats/turbine => 400 – 660 bats



Photos: E. Arnett

Sites with Bat Data



Data: Arnett et al. 2008, J. Wild. Man. 71:61-78
R.M. Barclay, personal communication

Patterns of Fatalities



Photos: E. Arnett



Migratory Tree-roosting Species

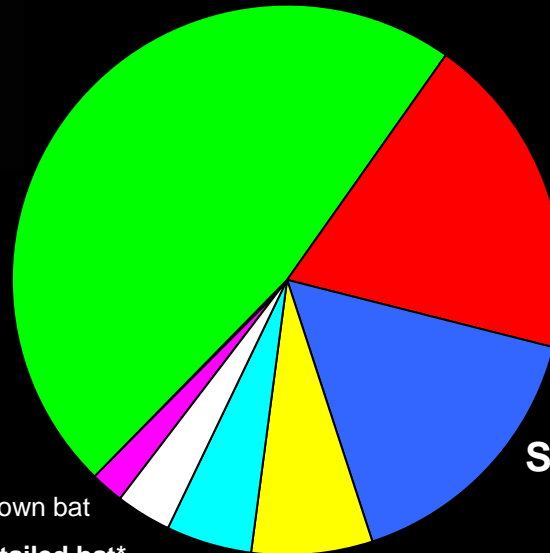


Hoary bat*



Photo: AC Miles

Eastern red bat*



Big brown bat

Free-tailed bat*

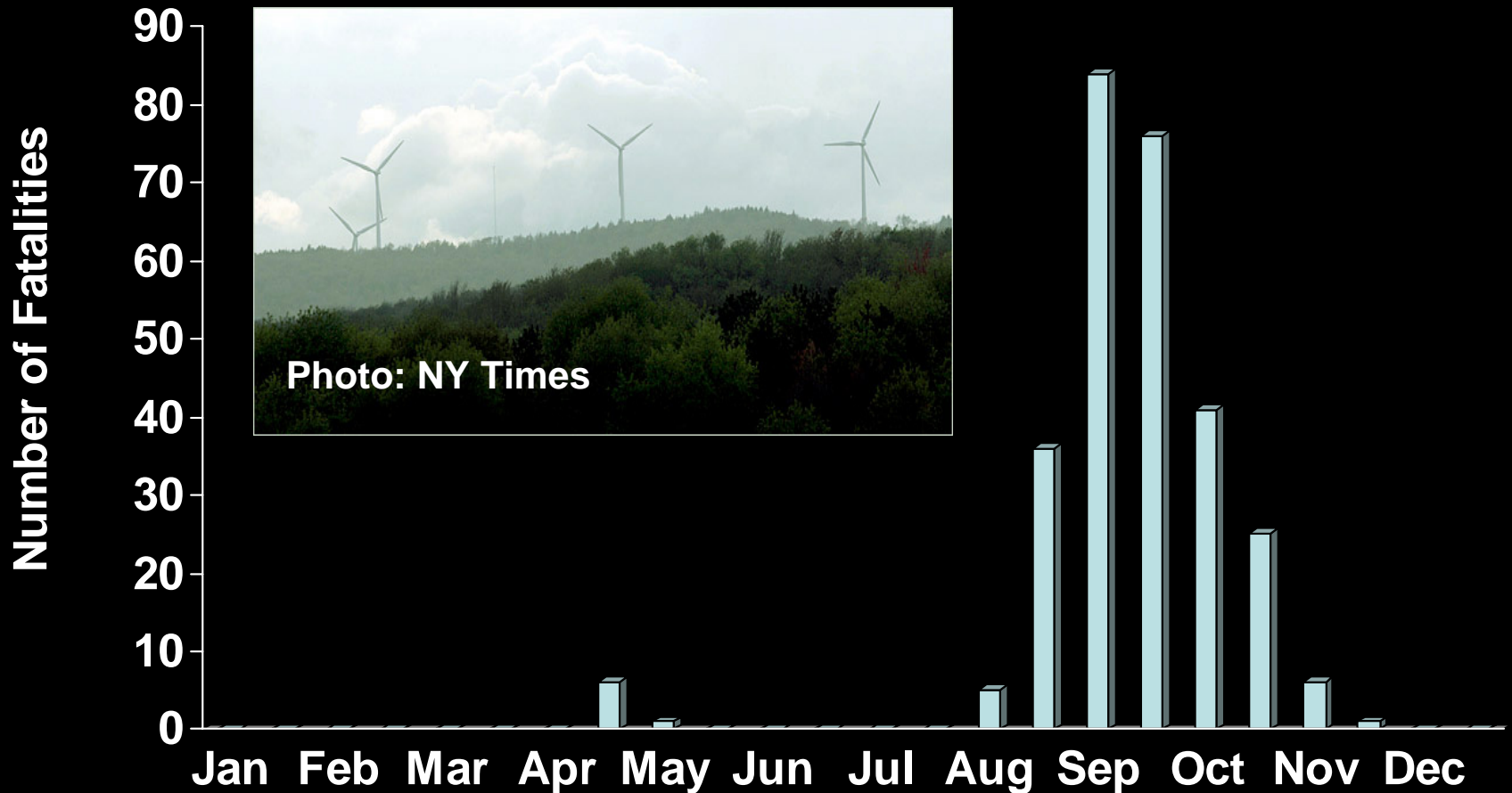
Little brown bat

Eastern pipistrelle?

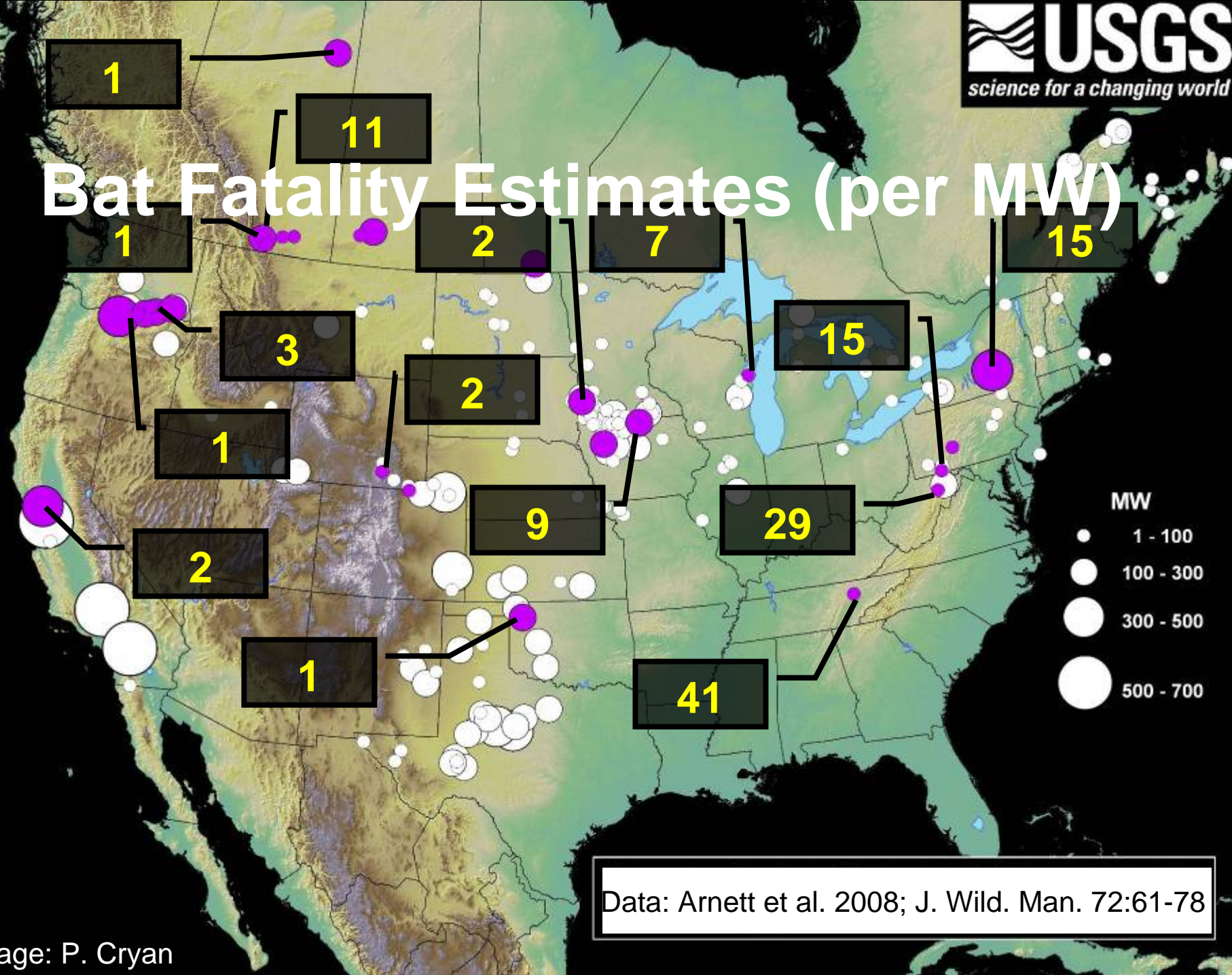
Silver-haired bat*



Timing of Fatalities



Bat Fatality Estimates (per MW)



Data: Arnett et al. 2008; J. Wild. Man. 72:61-78

The search image changes.....



Photo: E. Baerwald

Greatest Impact: Migratory Species

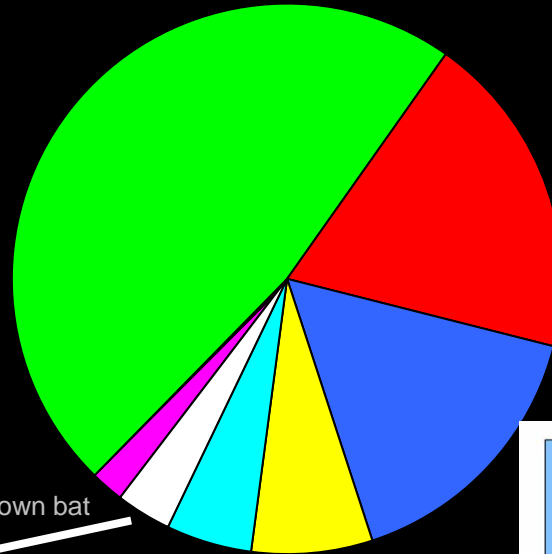


Hoary bat*



Photo: AC Miles

Eastern red bat*



Mexican Free-tail

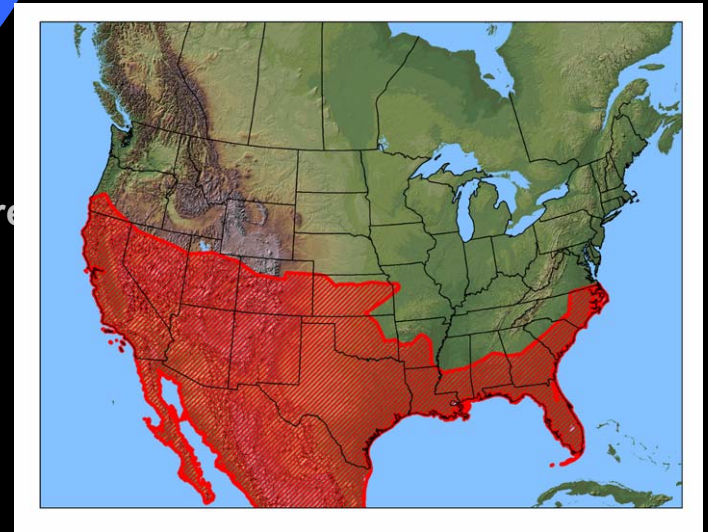


Big brown bat

Little brown bat

Eastern pipistrelle

Photo: J. Chenger



Potential Explanations

- Attraction to lights on turbines
- Attraction to sounds from turbines
- Not echolocating
- Attraction to linear corridors



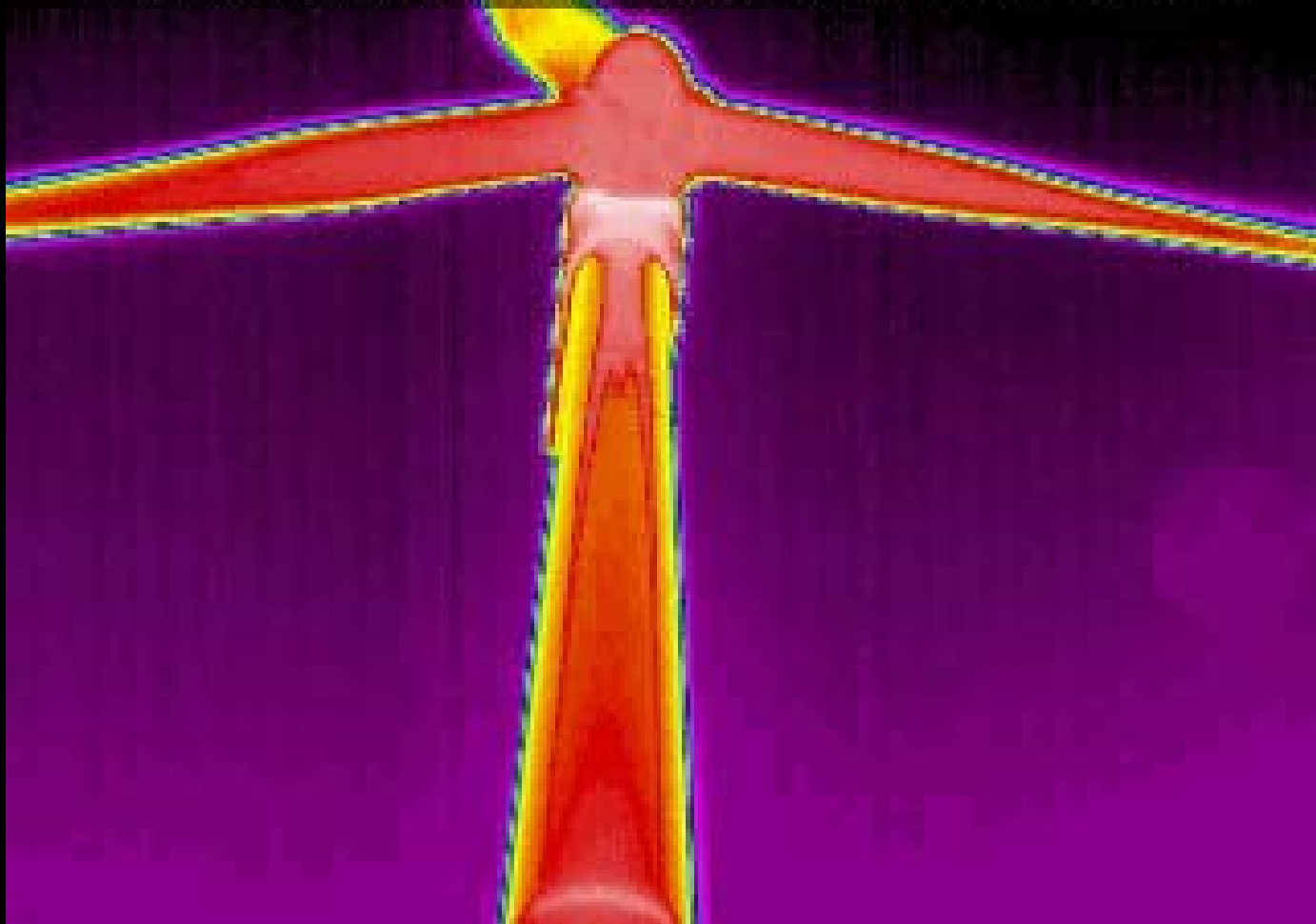
- Attraction as potential roosts
- Attraction to insects at turbines
- Bats crash into stationary objects

Bats Avoid Stationary (*and slow moving*) Objects

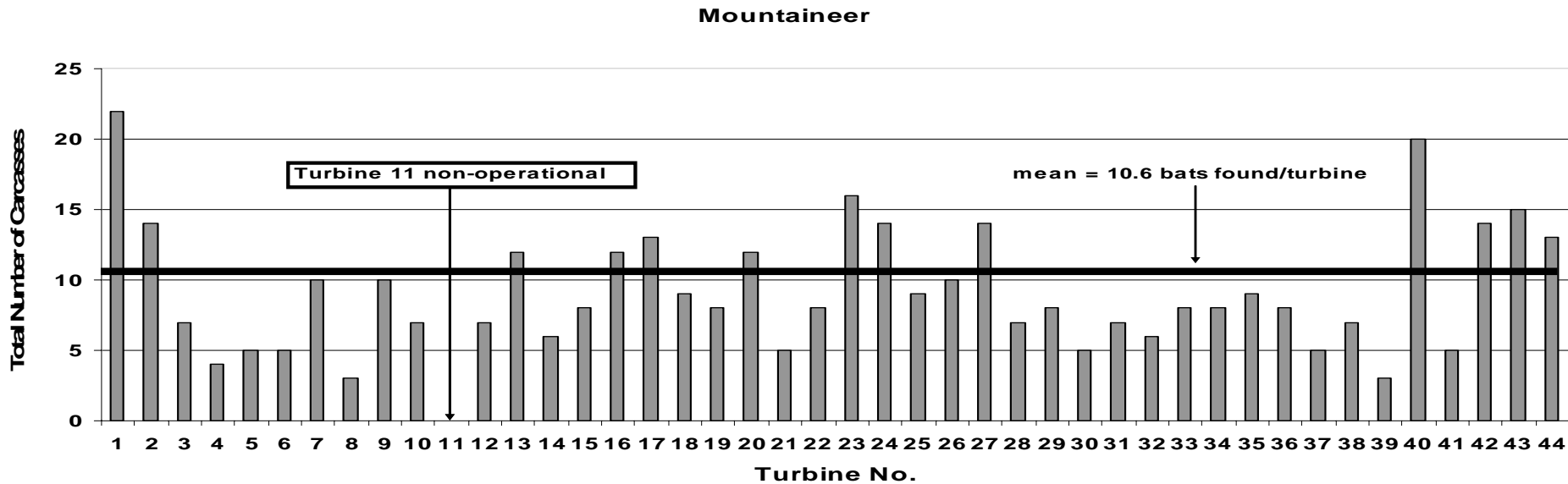


Bats Can't Avoid High Speed Collisions

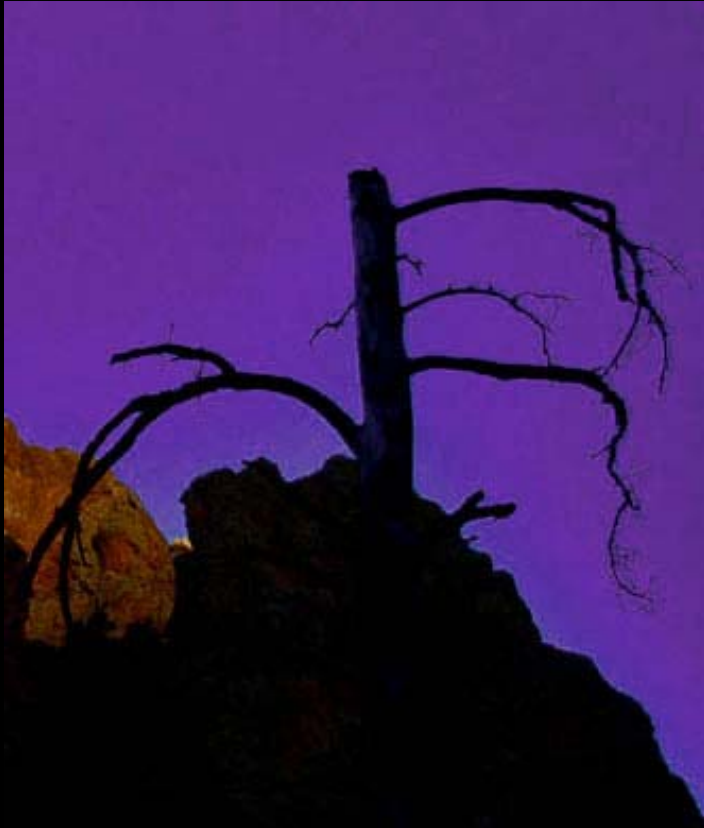
<http://www.bu.edu/ceeb/wind/video/> © 2005 Jason W. Horn



Fatalities at Moving Turbines

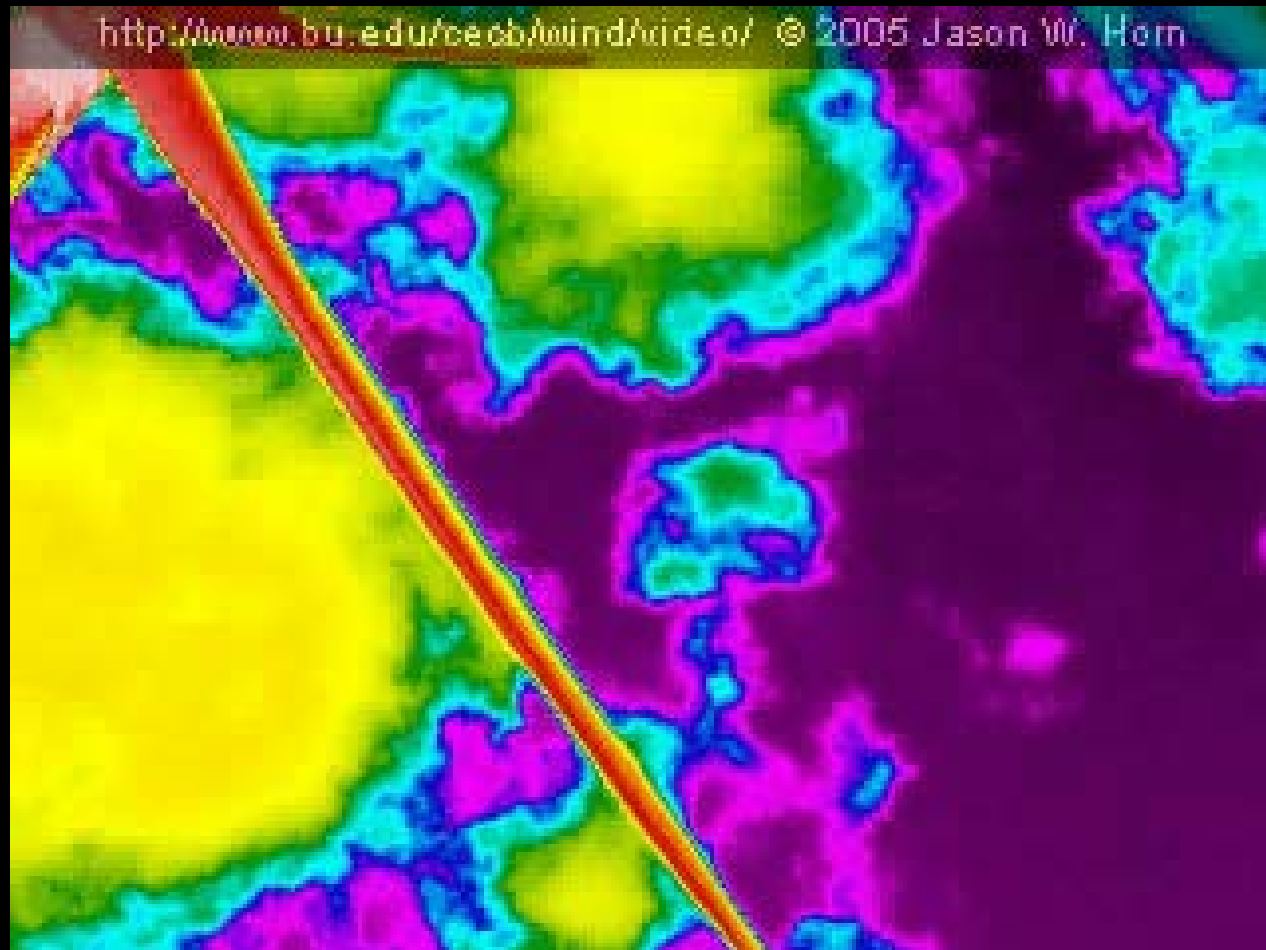


Attraction as Potential Roosts?

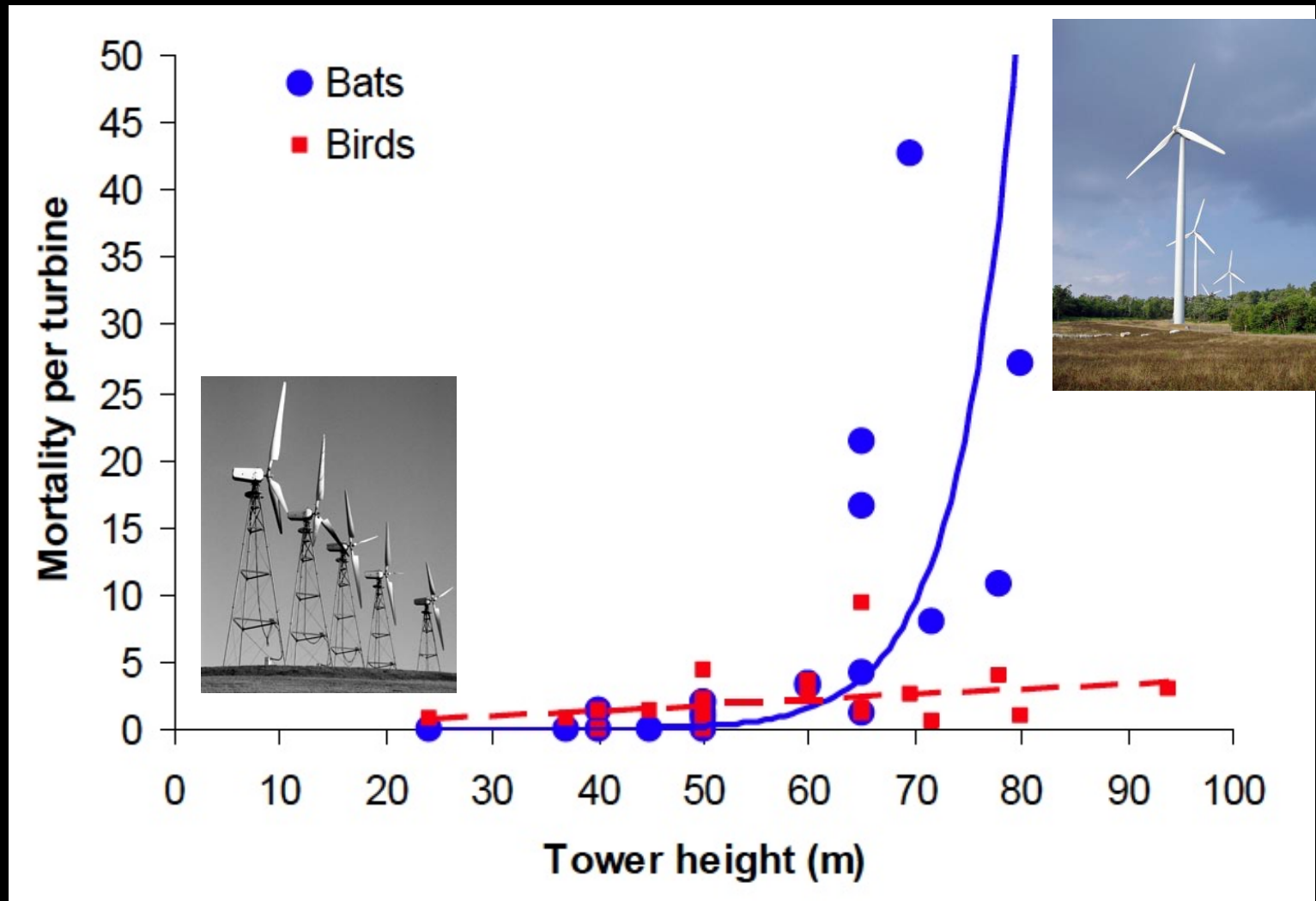


Photos: J. Szewczak

Attraction to insects at turbines?

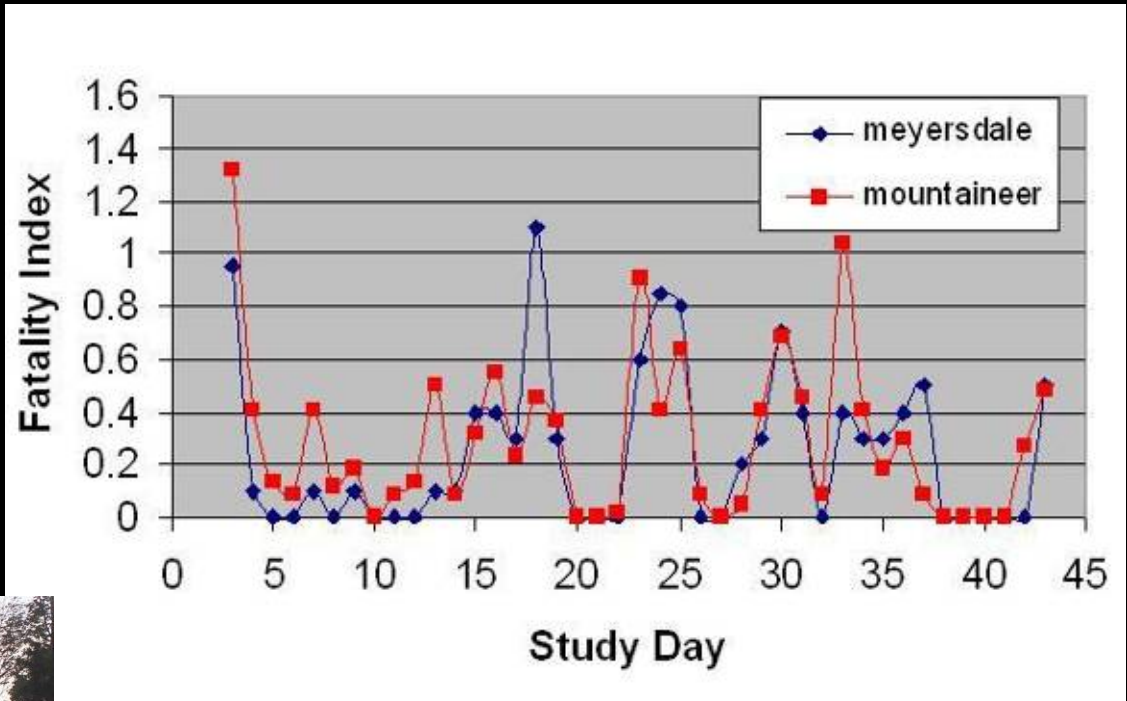


Bat Fatalities Increase with Turbine Height



Timing of Fatalities

- Highly variable
- Episodic
- Spatially correlated

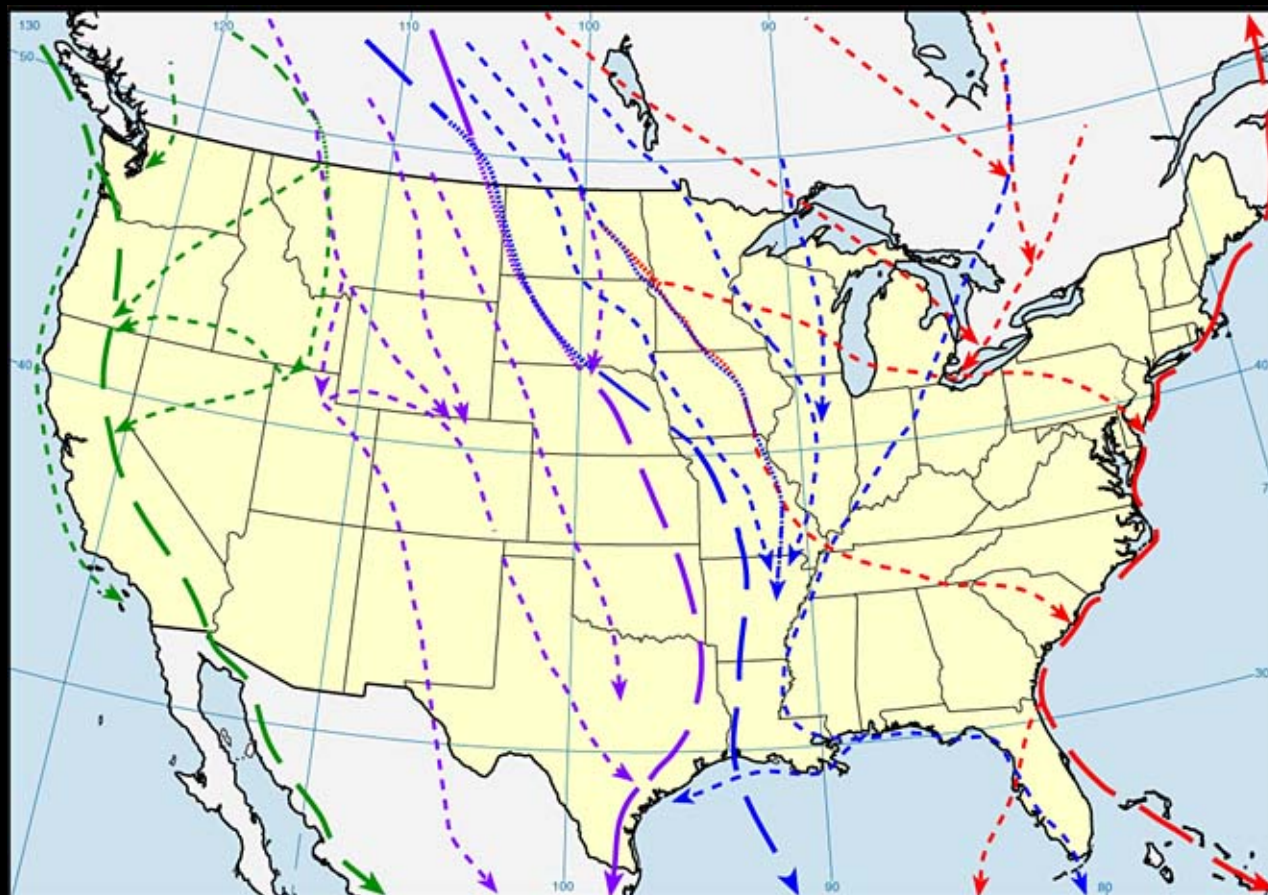


Arnett et al. 2008; J. Wild. Man 72:61-78
Kerns et al. 2005; BWECC

Predicting Risk

Designing Mitigations

Bird Migration Routes



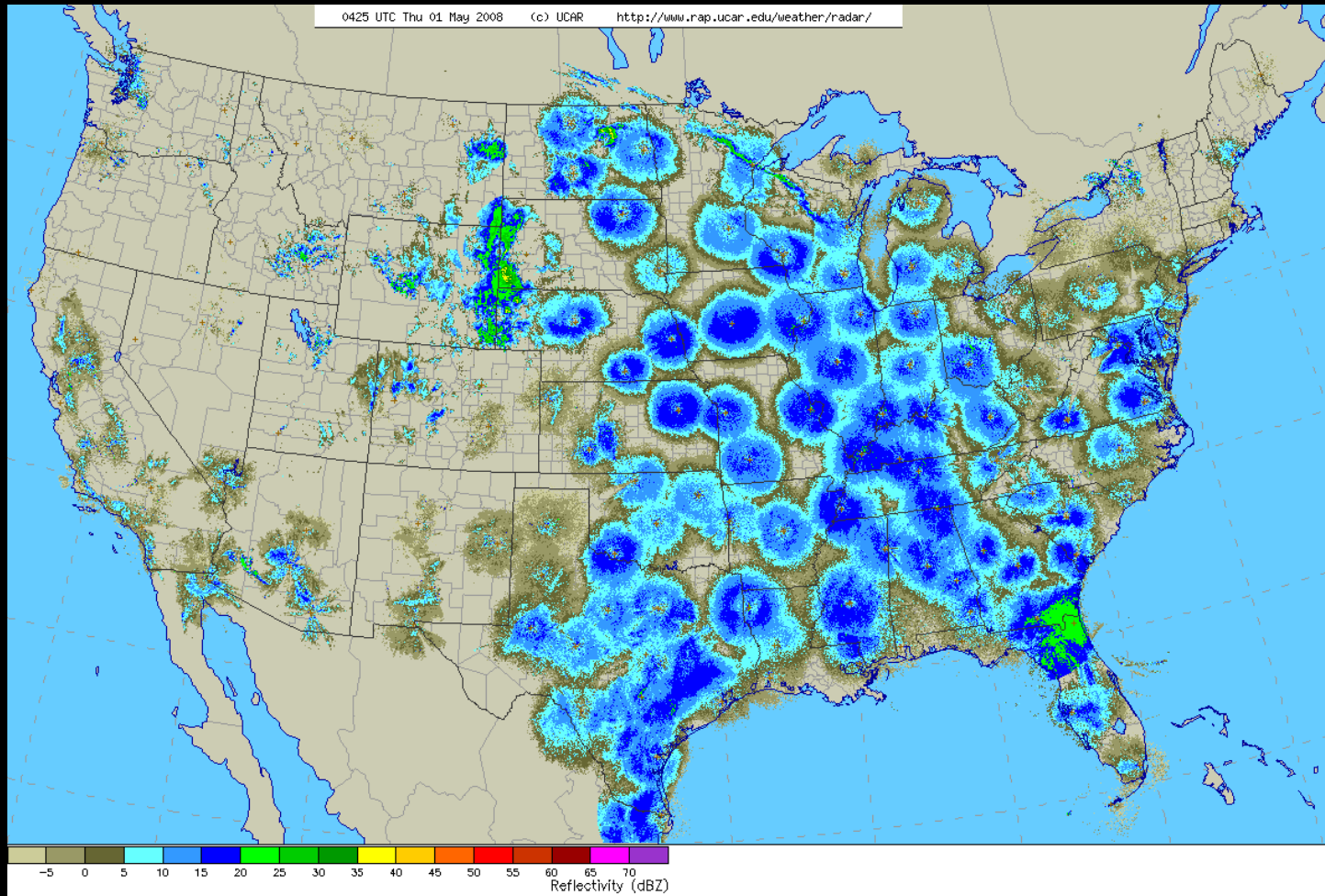
*North American Migration Flyways
(with Principal Routes)*

Atlantic Flyway	—
Mississippi Flyway	—
Central Flyway	—
Pacific Flyway	—



National Geographic

Nocturnal Spring Migration



May 1, 2008, 22:25 CDT

Avoiding Sites with High Bat Activity

- Thermal IR
- Echolocation Detectors
- Radar
 - NEXRAD
 - Marine
 - Fixed Beam



Bracken Cave, Texas

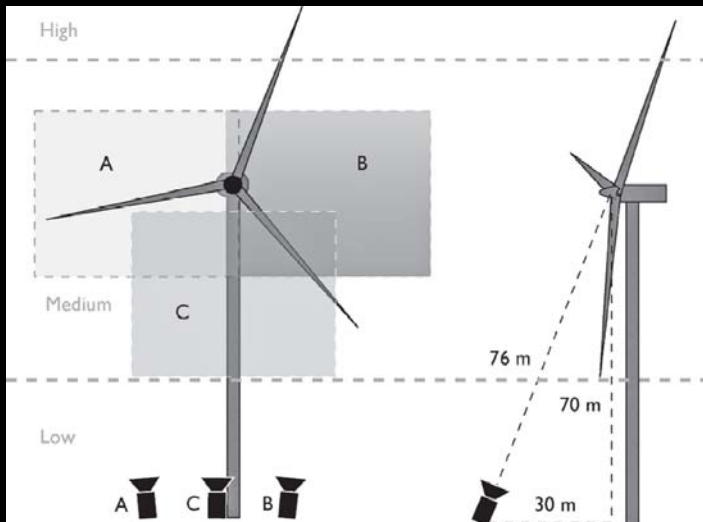
Thermal IR Imagery

Strengths

Excellent Behavioral Information

Information from Rotor-swept Zone

“Easy” to tell Bats from Birds



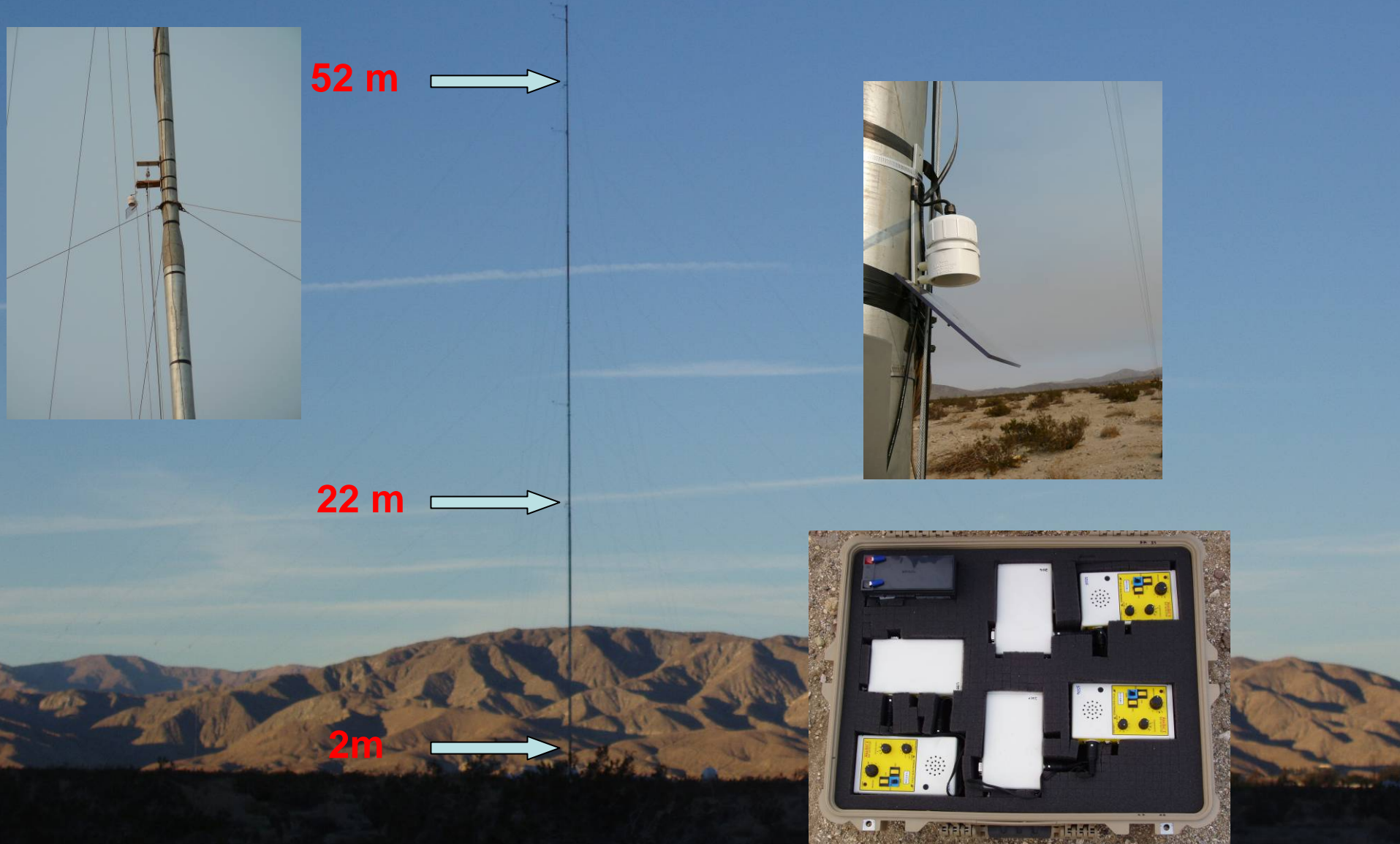
Limitations

Limited Field of View

Cost/Technology Change

Snapshot in Time

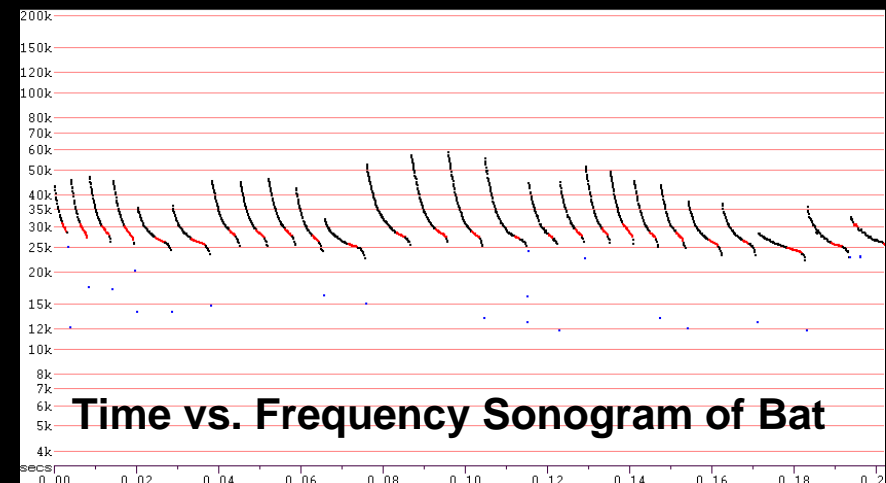
Echolocation Detectors on Meteorological Towers



Predicting Risk – Avoiding Sites with High Bat Activity

Echolocation Monitoring

- **Strengths**
 - Bat-specific
 - Temporal replication
 - Spatial replication
- **Limitations**
 - Link to fatalities not established
 - Sound Attenuation
 - Bat activity not bat #s



Marine Radar

X-Band Radar

- **Strengths**

- **Highly Mobile**
- **Passage Rates (targets/hr)**
- **Altitudinal Distributions**



Photo: M. Tuttle

- **Limitations**

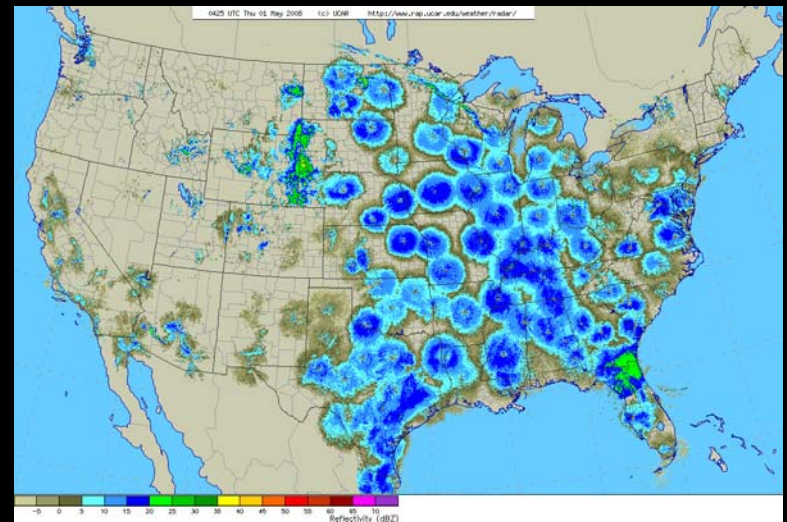
- **Can't distinguish bats from birds**
- **Terrain and Weather**
- **Limited Period of Deployment (30-45 days)**

Doppler Radar

Next Generation Radar (NEXRAD)

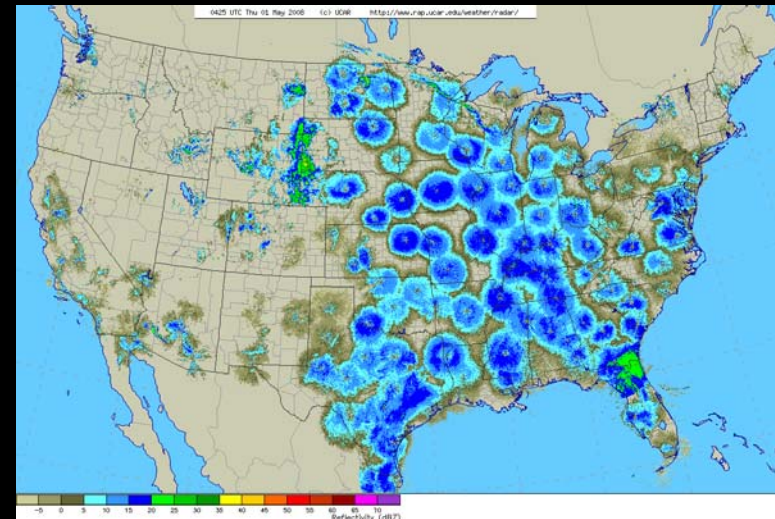
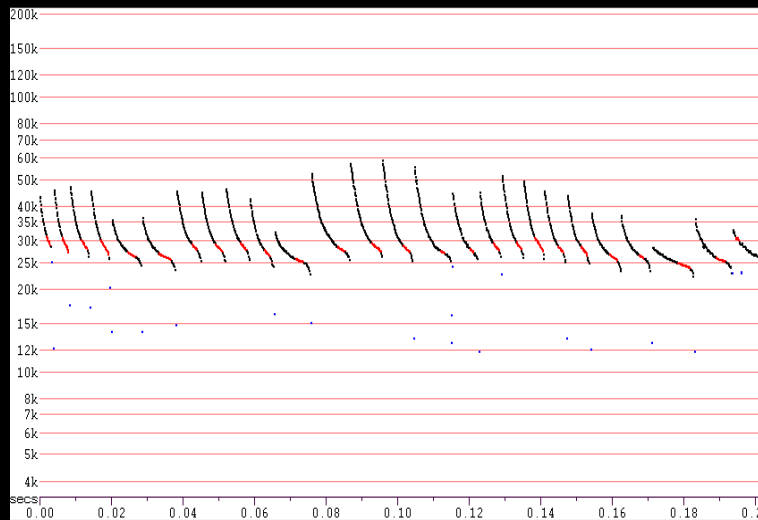
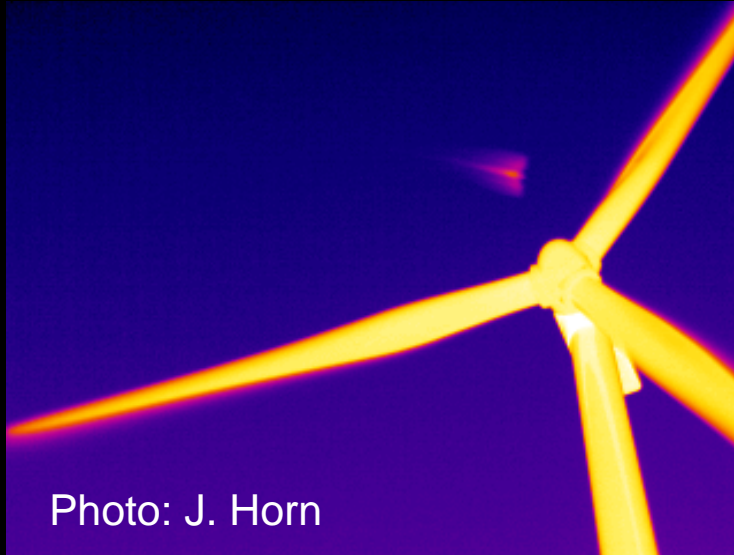
Weather Surveillance Radar

- **Strengths**
 - Large-scale movement patterns
 - Continuous operation
- **Limitations**
 - Can't tell bats from birds
 - Activity levels above turbine height
 - Not transportable
 - Many not available to researchers



NPOL: Polarimetric Radar?

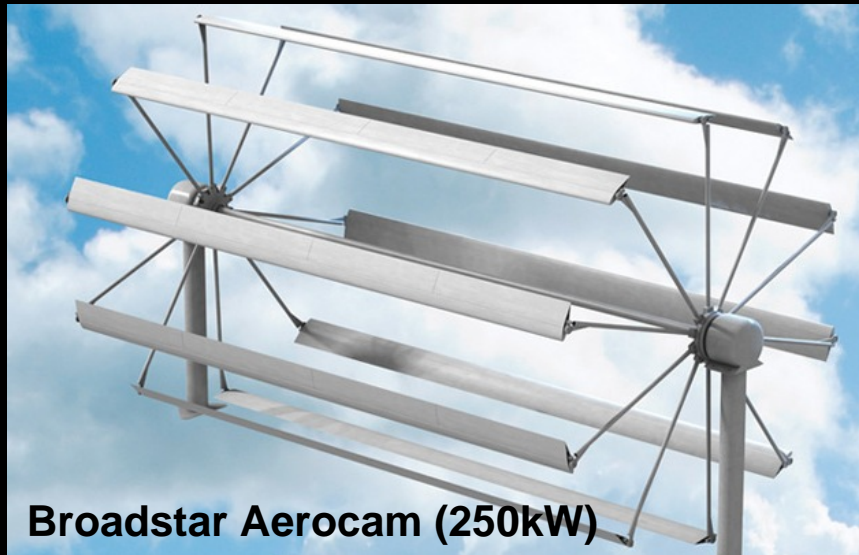
Combining Methods for Maximum Resolution



Possible Mitigations



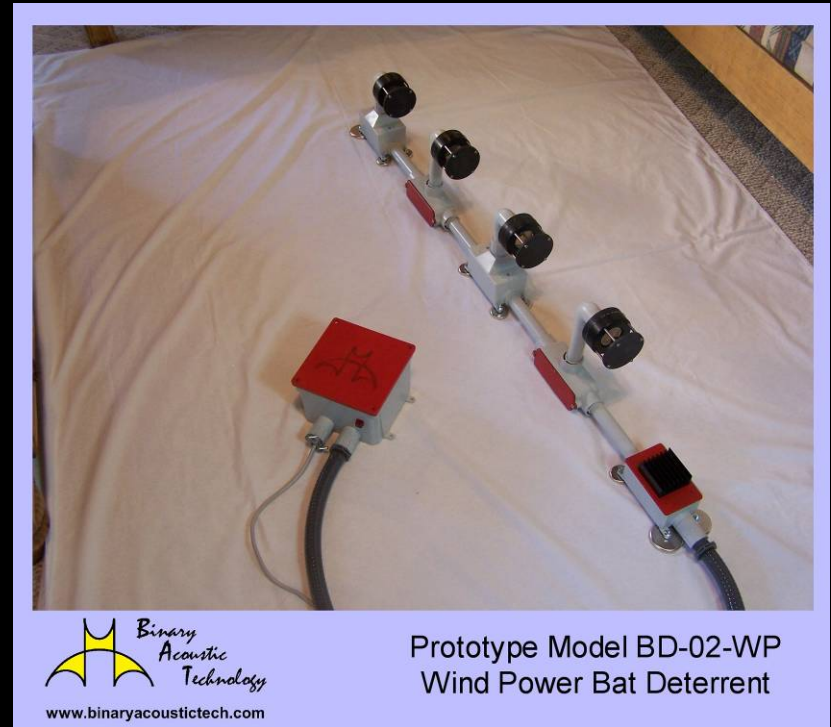
Turbine Design



Broadstar Aerocam (250kW)

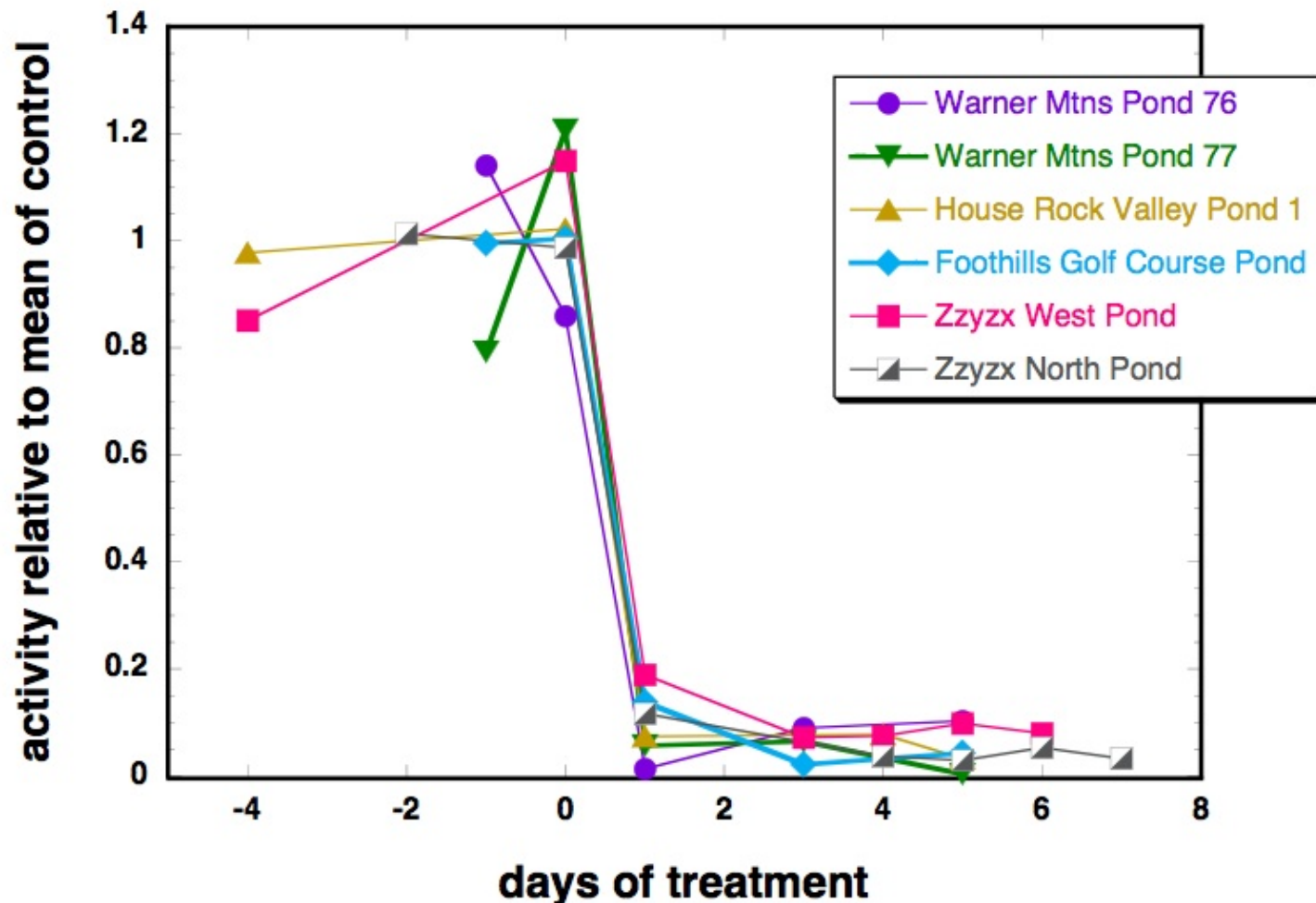


Acoustic Deterrent



Ultrasound broadcast unit -- developed by Binary Acoustic Technology

Bats Avoid Ultrasound “White Noise”



Ultrasound Fence?

Limitations:

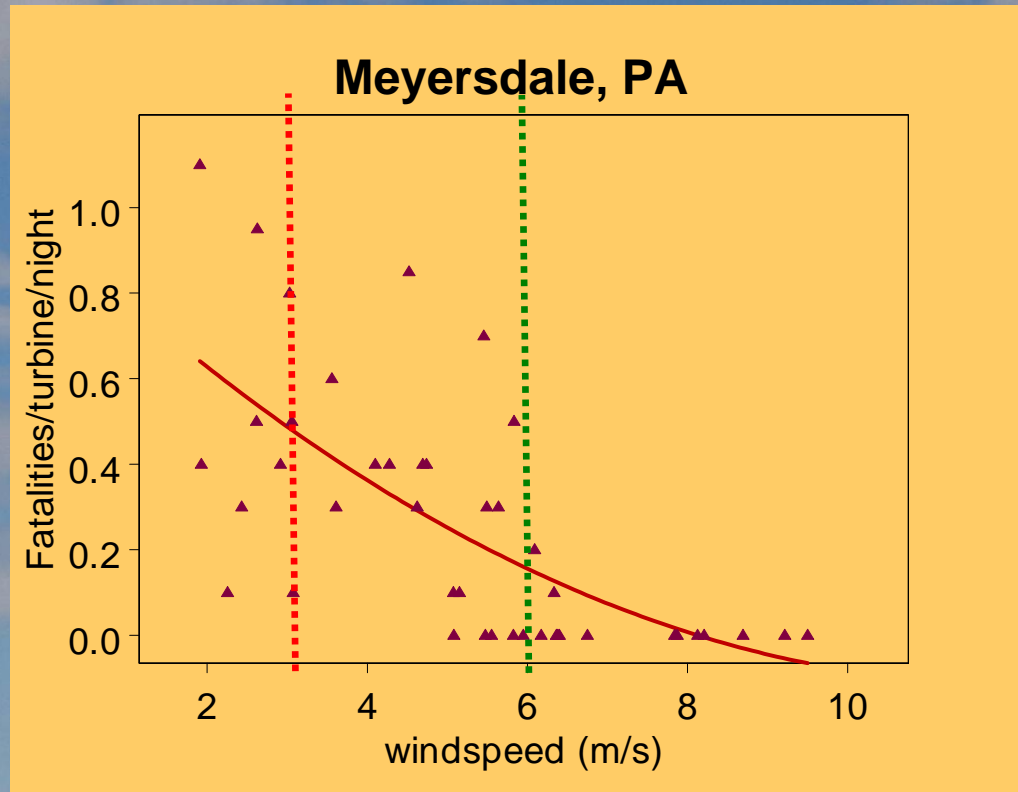
- Sound attenuation (30m)
- No. of units per Facility?

Biotic Sounds?



Image: J. Szewczak

Change Cut-in Speeds



Incorporate Collision Risk into System Operations

Bat activity and fatalities monitored at 35 wind facilities in Germany

Goal: Predict collision-risk based on meteorological data



Photos: R. Brinkmann



DeTect Inc.



Acknowledgements

- **Paul Cryan, USGS, Fort Collins Science Center**
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- **Erin Baerwald, University of Calgary**
- **Robert Brinkmann, Leibniz Universität**
- **Michael Durham, Durmphoto**

Photo: E. Baerwald

A wide-angle photograph of a desert landscape. In the foreground, a large wind farm with numerous white turbines is visible. Behind the turbines, there are several high-voltage power line towers. The background is dominated by a massive, rugged mountain range with significant snow cover under a blue sky with scattered clouds.

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